B-layer/Thermal Barrier Integration with Pixel Global Support Frame

Proposal of Scope

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Presentation

- This is a modified version of a presentation given at the last Pixel Mechanics meeting at CERN
- Proposals presented here are same in scope to those presented to Pixel Community
- This presentation contains slightly more detail as to convey the subject to those unfamiliar with the history of Pixel integration over the past few months
- Several Proposals are made here which represents the integration of several co-located structures into one, with the aim of de-coupling the designs of exterior detectors from impacting LBNL deliverables

Reminders

- **Proposal to put permanent rails in detector**
  - Ramifications
    - More mass in detector
    - Includes Services out one side, doubles mass on one side
    - Eases installation by reducing complexity
    - Does not require tooling which is impossible to make
  - Progress/areas for improvement
    - Progress on Self-Baking beampipe, proposed study of thermal coupling to B-Layer
    - Rails/Support points in Forward SCT accepted, but need work
    - Tooling Beyond that which is permanently installed not well scoped, responsibility ill defined

Thermal Barrier

- **History of Thermal Barrier**
  - General problem
    - detector volume is ~-10C Cavern Air dewpoint is +13C
    - Limited space
    - No Condensation allowed
    - Detectors die by the truckload if warm after irradiated (extreme case)
  - Known trouble with old solutions
    - Thermal Barrier is not a well defined structure
    - Multiple penetrations for B-Layer support, services
    - Ill-defined support conditions of portion exterior to pixels could lead to unquantified forces exerted on pixel structure
  - Proposed integrated solution
    - Moves Thermal Barrier interface to envelope Boundary of Pixel Detector
    - Has single interface to Barrel Thermal Barrier
    - Integrates B-Layer support/installation rail into Thermal Barrier obviating need for penetrations

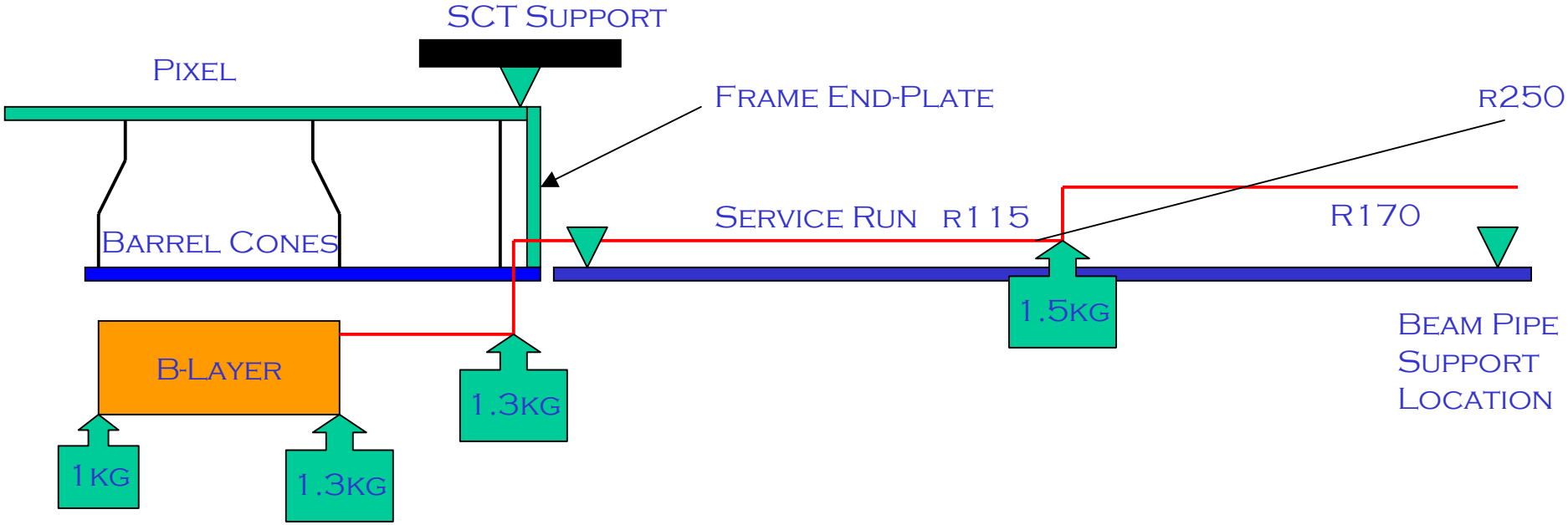
B-Layer Installation

- **Updates on work in progress**
  - Requirements/Necessity
    - Looking at beampipe design which does not require B-Layer removal for maintenance
    - Finite Detector Life still requires yearly removal of B-layer
  - Access
    - Short Opening Scenario little changed
  - Constraints
    - Space limits-during Access remain the same
    - Alignment Grid increased, somewhat moot if rails are used
    - Thermal Barrier In forward SCT will allow us to support services and a rail

Beam Pipe Work in Progress

- **Double walled beampipe accepted as goal**
  - Allows for bakeout/NEG reactivation without b-layer removal
  - does not require installation of bakeout equipment
- **Considerable testing and analysis has gone into the study of the viability of this design**
- **Looking to have TDR like design information by end of year**

Permanent Rails



- **Proposed to mount rail off of frame end stiffener and barrel support cones**
- **Services out one side**
- **Rail in SCT Forward--also permanent**
- **Support of services off of SCT Forward Thermal Barrier (via rail)**
- **Try to integrate B-Layer installation with B-Layer support**

Ramification of Proposal

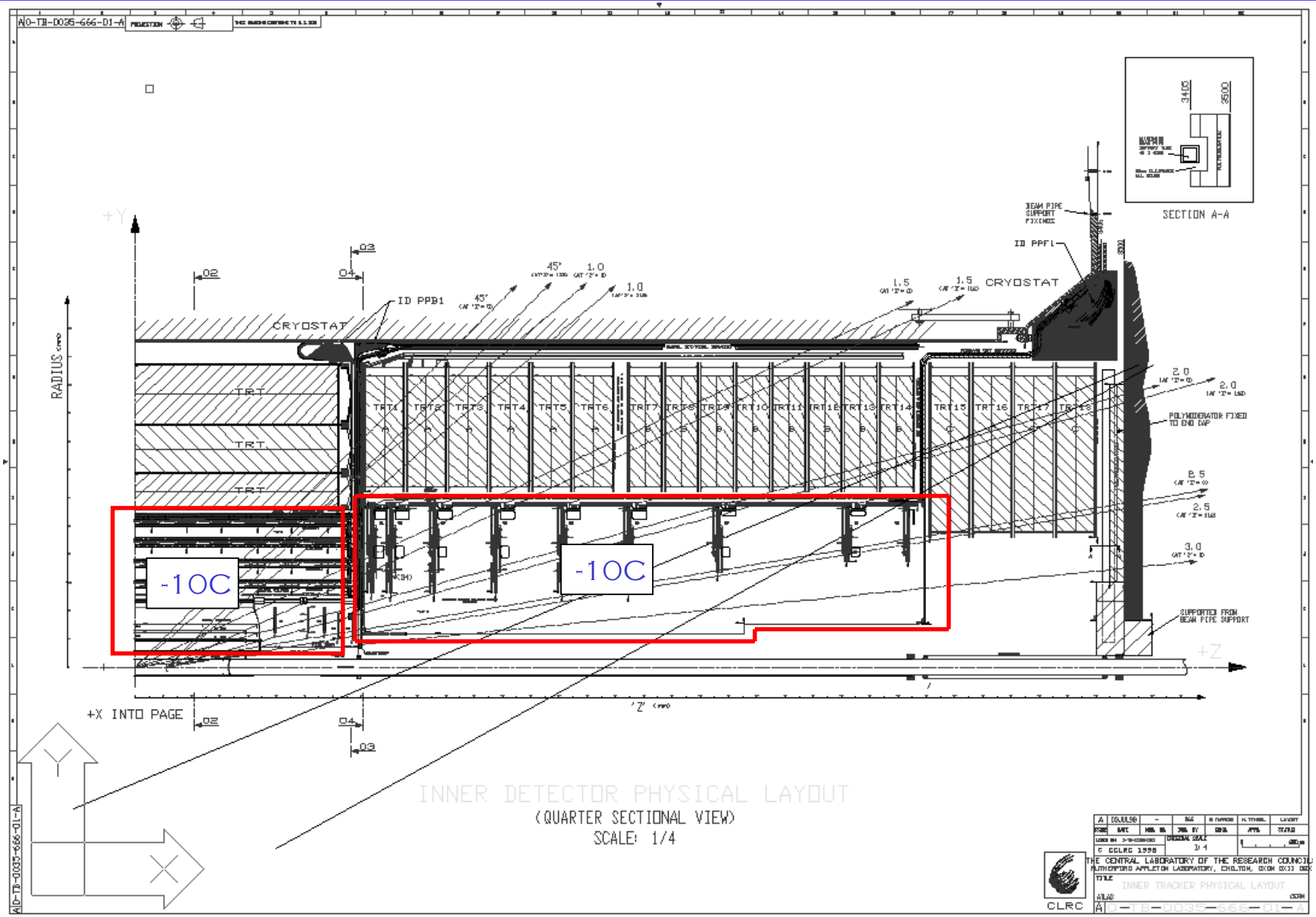
- Simplifies assembly of B-Layer, arguably, makes possible…
- Increased services on one side of detector and in center section
- Requires tighter integration with SCT Forward
- does not address thermal barrier penetrations

Thermal Barrier Requirements

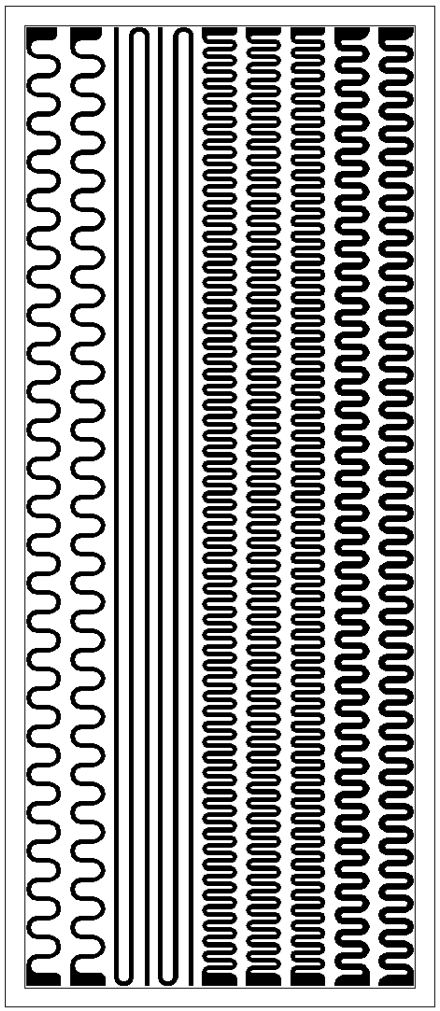
- The Volume for installing the B-Layer is filled with Cavern Air -- Dewpoint of 13 Deg C
- Detector Volume is as low as -15 Deg C-- Thermal Barrier must stand-off ~30 Deg C thermal gradient in minimal space
- Structure of Thermal Barrier minimized for X0
- No Condensation is allowed on any surface within the detector
- Design requires Knowledge of Installation and Removal Scenarios, Times and failure modes

These requirements lead to an active thermal barrier requiring heat input on the exterior surfaces to meet boundary conditions

Pixel Detector



Thermal Barrier Construction

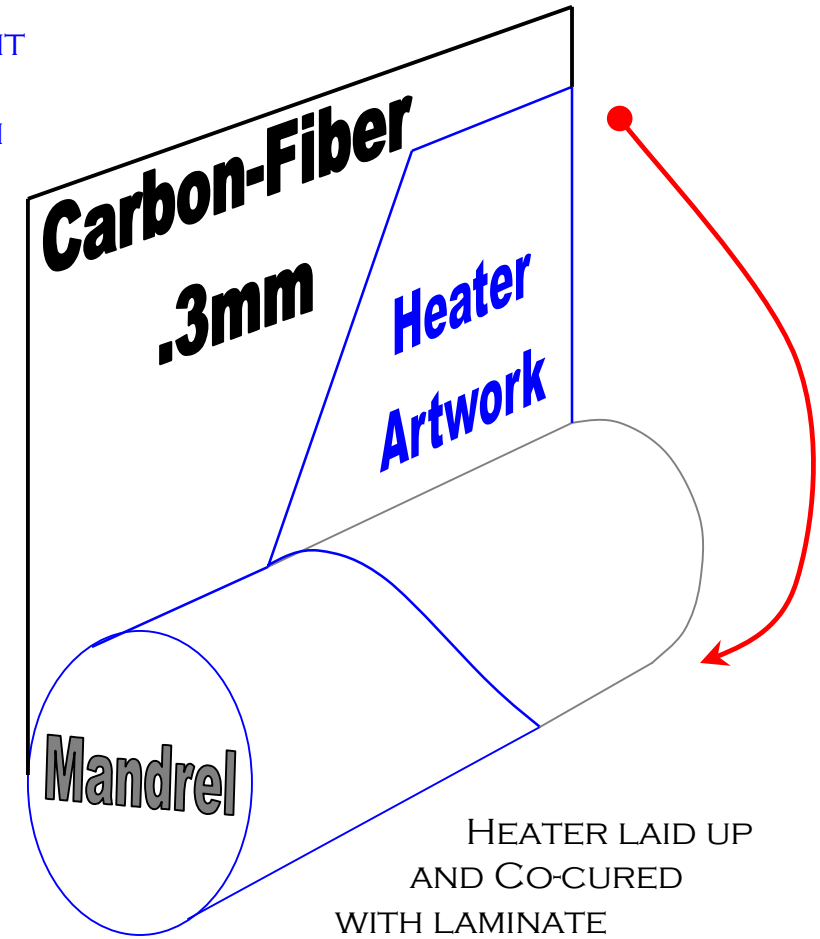


Test Artwork for current Limit testing. Left Sets have equivalent radiation lengths. Slightly more heat is required at penetrations and boundaries

Test program on:
Double-Sided Al-Kapton
20micron AL
50micron Kapton

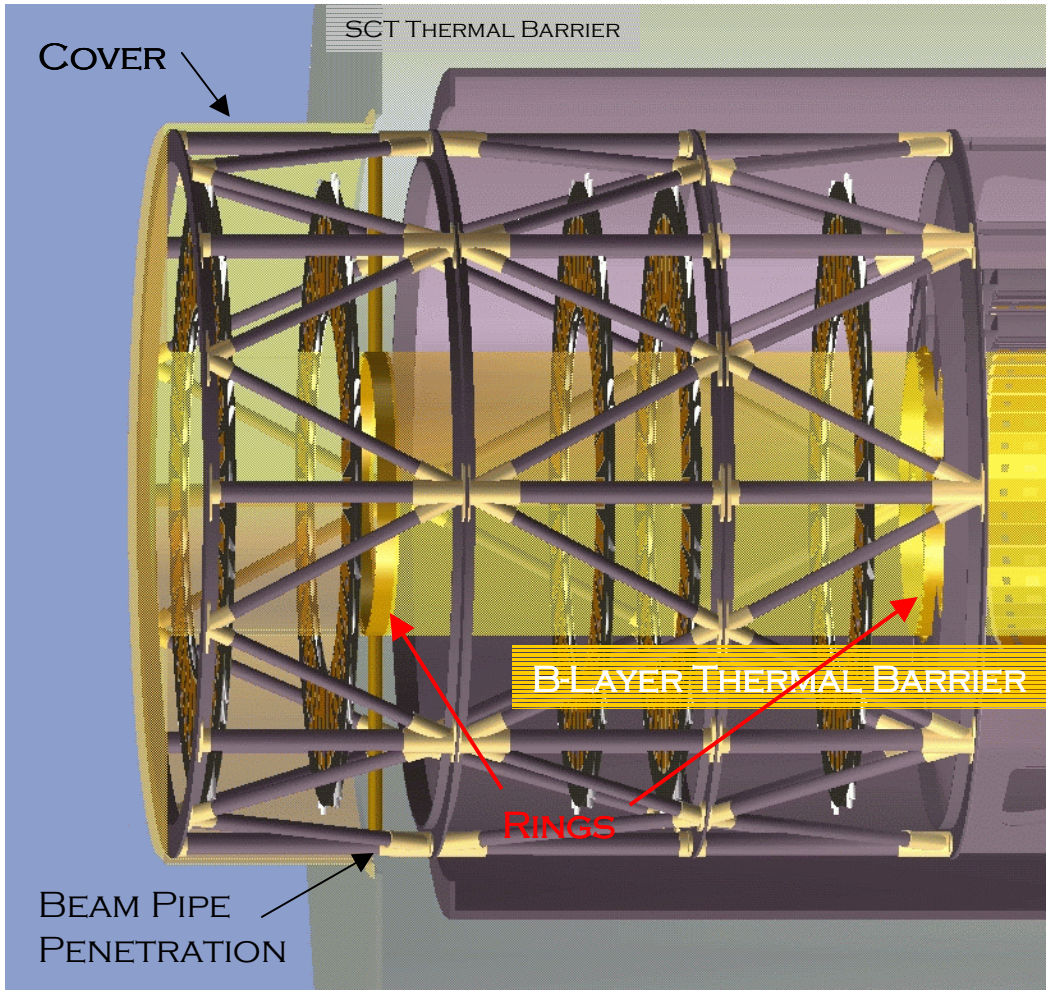
Heater patterns etched in one side

Design goal:
1-Amp / trace
2 traces / square cm
(traces have 5mm pitch)



Heater laid up and Co-cured with laminate

Heat Leaks/Penetrations

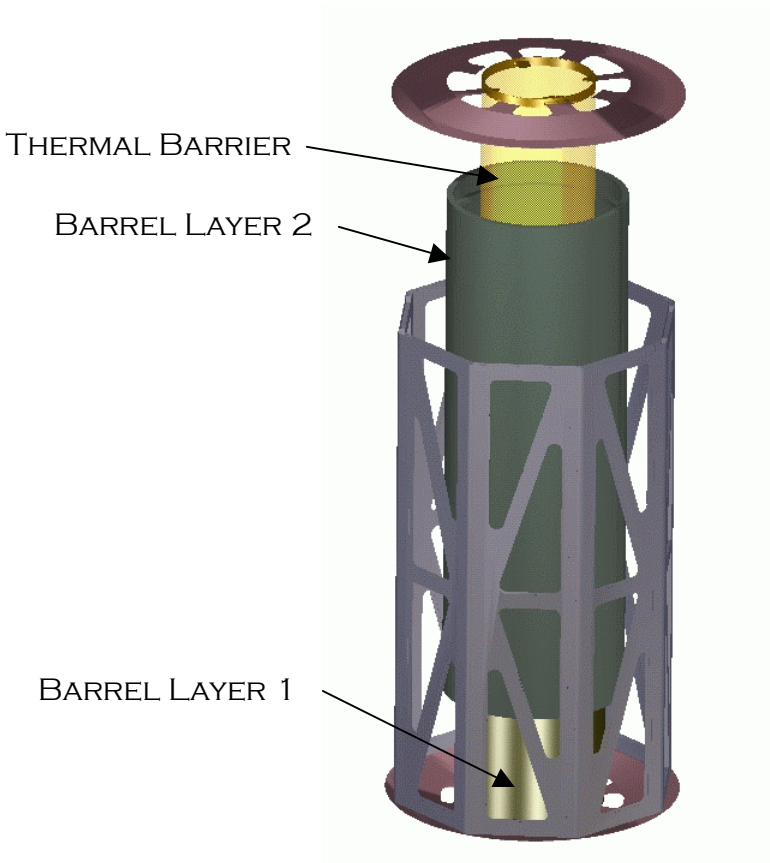


Note: this is an extremely old Illustration. It is used to here only to illustrate a problem

It is necessary to seal at every penetration. Where there is a penetration it required a ring to seal the cylinders to.

At every seal it is necessary to guarantee that no cold gas leaks as well as providing no thermally conductive path.

Nominal "Base-Line" Design



- Thermal barrier in three parts (Central + 2forward)
- Tied support fingers together with insulator/seal
- Potential for leaks next to beampipe and b-layer
- Needs structurally de-coupling seals

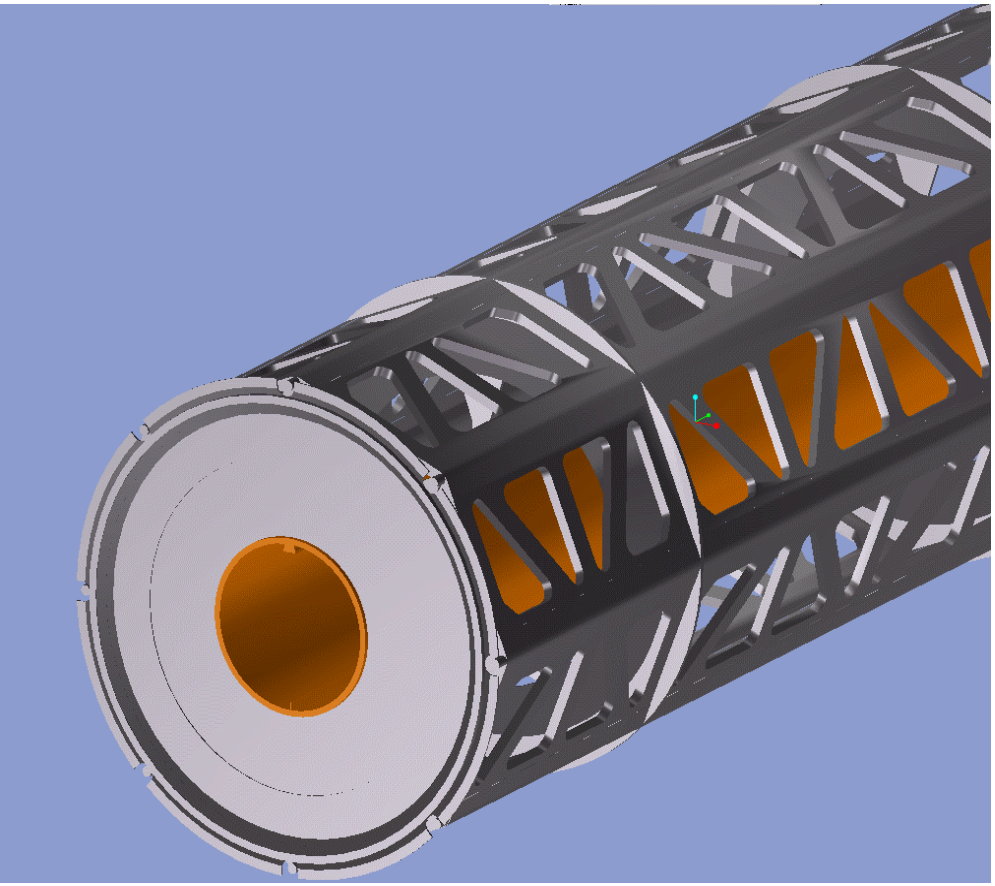
Three Structures

- **There are three structures in the general area of the end of the frame**
  - Thermal Barrier
  - Service Strain relief
  - Endplate Stiffener
- **It is obvious that the strain relief for the services would be integrated into either the end of the frame or the Endplate stiffener**
- **Proposed:**
  - to shift the integration of the strain relief into the Endplate stiffener
    - To simplify the interface between the services and the deliverables from Hytec
  - to make the endplate stiffener an LBNL deliverable
    - It was not a part of the original Hytec contract
    - LBNL is responsible for the integration of services

Thermal Barrier Problems

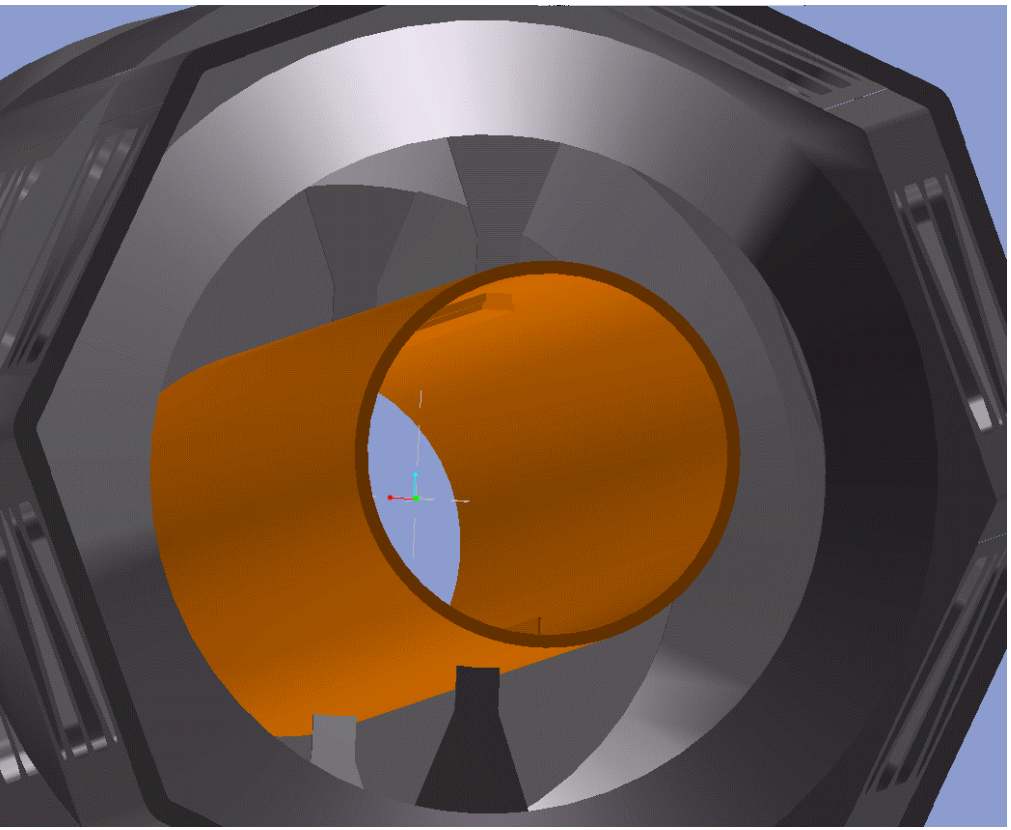
- **The thermal barrier is not currently well integrated into the Pixel Structure, however:**
  - it penetrates our volume
  - is directly coupled to many different systems, including its own cooling system, the Barrel SCT, and the TRT support arms
  - is currently poorly supported with design effort, and as such represents significant risk to US deliverables to which it must couple
- **Propose**
  - Integrate our part of the thermal barrier into our structure
  - Define unique simplified interface to SCT Barrel thermal barrier-decoupling its design from our progress
  - Support our portion of the thermal barrier off of the closest pixel structure which is the service strain relief plate

Additional Proposal



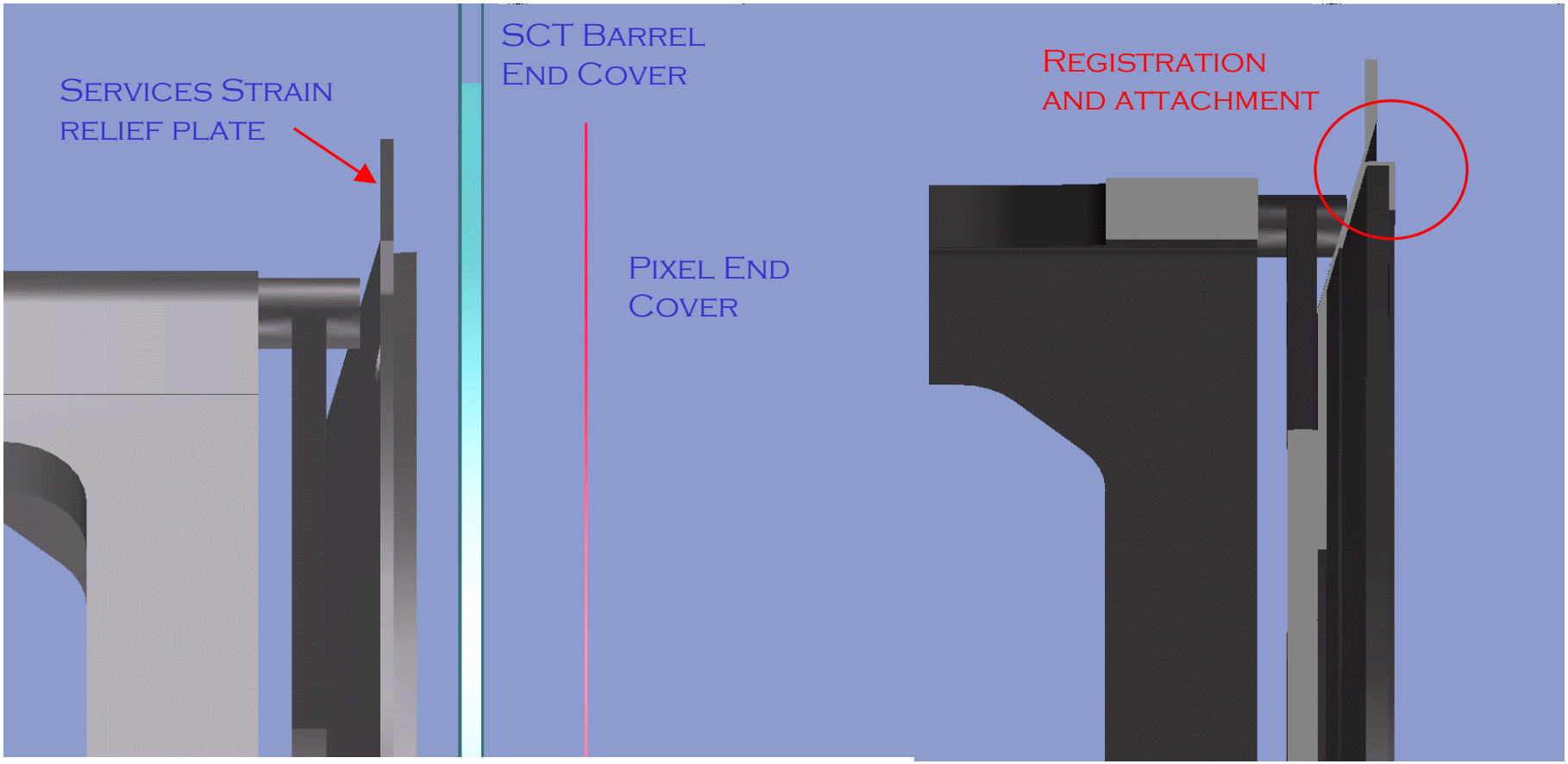
- Integrate Support rail into Thermal Barrier--Solves problem of thermal penetrations/interfacing
- Support Thermal Barrier from Frame Stiffener
- Make Frame Stiffener Inner Wall of thermal Barrier
- Provide tie points from support cone to exterior of Thermal barrier to locate b-layer
- Provide interface to Remainder of Barrel Thermal Barrier

Change of Support

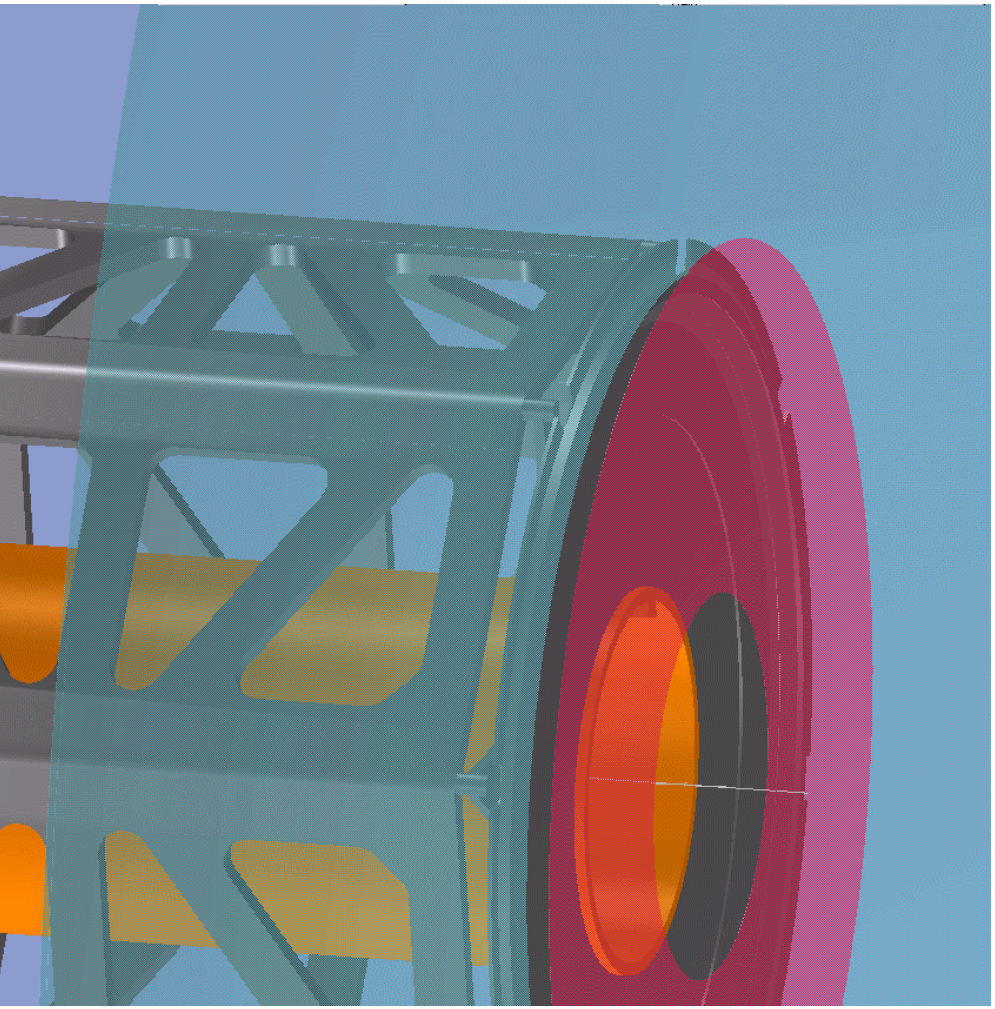


- Recommend changing B-layer support to vertical plane
- Hang from upper rail, get orientation from lower rail
- Fingers benefit in z-stiffness from z-stiffness of endplates
- Rail benefits from bending stiffness of thermal barrier
- Simplifies interface by avoiding penetrations

Detail of Barrel TB interface



Precise Parts



- Endcap of Barrel TB is Trapped only in z, radial motion is allowed
- Integration of thermal Barrier with Support allows for more well defined interface with external thermal barrier
- Due to space Constraints and interfaces/seals, thermal barriers were necessarily accurate structures

Propose to Build

- **End Stiffener Plate Prototype**
- **Thermal Barrier Prototype**
- **>>Discuss scope with Gil**
- **do we include Rail and Support cone**
  - ambition
- **To include in separate presentation or with this?**
  - schedule
  - Hardware/Equipment list

Discussion

- Sources of Error
- Z-Stiffness
- Pressure Variation
- Assembly tooling not included